

Special Articles

BOTULISM*

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The occurrence of several outbreaks of botulism within the past few months and particularly the prominence given in the press to two outbreaks which have occurred in the eastern states, has awakened active interest in the subject in all parts of the country. It is now generally accepted that botulism is a type of food poisoning which must be seriously considered by all who undertake the preservation of perishable foods, and it has become necessary to make a careful survey of the methods used in preserving foods to ascertain whether they will insure destruction of the spores of *Bacillus Botulinus* should they happen to be present in the raw material. Practically all the outbreaks which have occurred within recent years have been caused by the consumption of home-canned vegetables and fruits, but within the past two years there have been at least four instances in which commercially canned foods were undoubtedly at fault.

It is a point of considerable interest that although several outbreaks of botulism have been observed in different states, the great majority of outbreaks have occurred on the Pacific Coast. In all we have record of 58 outbreaks of poisoning of this type in America, 45 in which human beings were poisoned and 13 in which domestic animals or fowl were affected after eating discarded home-canned foods.¹

Of these 58 outbreaks, 41 occurred in California, 5 in Oregon and Washington, and 3 which occurred in the eastern states were caused by the consumption of ripe olives which had been packed in California.

There have been, therefore, at least 49 recognized outbreaks of botulism in which the infecting organism has been definitely traced to the Pacific Coast, a fact which cannot be disregarded when selecting an area in which to study the natural habitat and biological characteristics of the *B. botulinus*.

There has been a considerable amount of discussion as to whether the food which is infected with *B. botulinus* and in which there is a potent toxin, shows sufficient evidence of spoilage to insure that it will be discarded by persons who are careful of what they eat. There is no doubt that food which contains the botulism toxin shows more or less marked evidence of spoilage and has a peculiar rancid or cheese-like odor which is in some cases extremely offensive. However, in several instances of which I have personal knowledge, the evidence of spoilage was so slight that even after smelling and tasting, the housewife, though recognizing it was not quite right,

decided that the food was fit for use. I am convinced that one must not depend upon marked evidence of spoilage as an indication of the presence of a potent toxin, but that all preserved food which shows the slightest sign of spoilage should be discarded without being even tasted. The housewife should depend upon her eye and sense of smell in determining whether food is fit for use, and when at all suspicious should not taste the suspected food to see whether it is good. There is a steadily growing list of women who have died of botulism because they tasted home-canned food which did not look or smell quite right.

Botulism as it occurs in human beings or in animals or in fowl is not an infection but is an intoxication. The *Bacillus botulinus* is a spore bearing anaerobic organism which grows well at room temperature and which in its growth in suitable medium produces a virulent toxin. The spores are extremely resistant to heat, so that if they are present on raw material which is being canned they are very apt to resist the heat which is applied to sterilize the food in the can or jar. If the spore survives the sterilizing process it finds an ideal place for growth in the hermetically sealed moist food within the can. It is the toxin which is produced within the container which causes the poisoning. The greater amount of evidence indicates that the bacteria themselves are not pathogenic and do not form more toxin after they have been taken into the gastro-intestinal tract with the food. The toxin is easily destroyed by heat, boiling the food for a very few minutes being sufficient, and there is no danger of poisoning of this type if canned food is boiled before it is eaten or even tasted. All the known outbreaks of botulism from canned goods have occurred when the food was tasted to see whether it was good, or was served uncooked, as salad, for instance, string beans or asparagus, as a relish, such as ripe olives, or as desert, such as apricots or pears.

The symptoms usually appear in from eighteen to thirty hours after the ingestion of the poisonous food, although they may appear in from four to eight hours. The earliest symptom is usually a sensation of languor and fatigue, but this is soon followed by characteristic disturbances of vision, blurring of vision, diplopia, and loss of accommodation. There is often early vertigo and incoordination of muscular movement. Dryness of the mouth and pharynx, a sensation of enlargement of the tongue and a peculiar sensation of constriction of the throat soon follow. There is marked inhibition on the serous salivary secretion, and the mucous portion is secreted in a thick, tenacious form which is removed from the pharynx with great difficulty. Speech soon becomes impaired and unintelligible, and there is difficulty and eventually inability to swallow. The patients suffer greatly from strangling spells induced by their attempts to swallow or to raise the thick mucus from the pharynx. There is rarely any acute gastro-intestinal disturbance, although there

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¹ This does not include outbreaks of forage poisoning in which domestic animals died after eating infected fodder.

may be initial nausea, vomiting, and diarrhea. A characteristic feature of the intoxication is that there is obstinate constipation which may be so severe as to resist all efforts to induce evacuation of the bowels.

There is early blepharoptosis and mydriasis with loss of pupillary reaction to light, and occasionally there is paralysis of all the extrinsic muscles of the eye so that the eyeball remains fixed in the socket. Occasionally there is paralysis of the muscles supplied by the motor portion of the fifth and by the seventh cranial nerves, but this is more uncommon. There is loss of the pharyngeal reflex in the majority of cases. There is marked general muscular weakness, but there is no true paralysis of the skeletal muscles and the skeletal reflexes are not lost. True paralysis is apparently confined to the muscles which are supplied by the cranial motor nerves.

A striking feature of the botulinus intoxication is that there is no disturbance of mentality and that sensation remains intact. There may be some inhibition of the sense of taste, but this is probably chiefly if not entirely dependent upon the absence of the serous salivary secretion. There is rarely any disturbance of hearing. The disturbances of vision are entirely dependent upon the loss of function of the intrinsic muscles of the eyes, as the retina rarely shows any change. There may be initial headache and nausea, but there is otherwise rarely any pain.

The temperature is usually sub-normal; in fact, when fever occurs, one should be strongly suspicious of the onset of some intercurrent infection such as broncho-pneumonia. The pulse rate may be slower than normal at first, but it soon becomes rapid and the combination of a temperature of between 96 and 97 degrees F. with a pulse rate of over 130 is very striking.

The intoxication usually reaches its maximum severity in from four to eight days, and then, if the patient survives, gradually subsides. Convalescence is very slow and tedious. In fatal cases, death usually occurs in from four to eight days and it is seldom that persons who survive for ten days succumb unless some complication such as aspiration pneumonia ensues. Death usually occurs from cardiac or respiratory failure.

The mortality in the American outbreaks has been extremely high as compared with that in Europe, probably because only those in which some of the patients died have been recorded. Of 189 persons who are known to have been poisoned in this country 133 have died, a mortality of 70.4 per cent.

The high mortality is indication of the unsatisfactory results which are obtained by treatment. It should be borne in mind that in botulism we are dealing with an intoxication and not an infection, and that the amount of poison ingested is limited since no new toxin is formed within the body. The problem of therapy therefore resolves itself into one of elimination and supporting treatment.

It is important to wash out the stomach even

though the poisonous food has been eaten several days before, as there is early inhibition of stomach motility. Purgation should be induced if possible, preferably with magnesium sulphate or some similar saline, and the lower bowel should be frequently washed by enemata. Simple nourishing food should be given in sufficient quantities and a generous supply of water should be administered, but it should be remembered that on account of the loss of pharyngeal reflex and the frequent strangling spells when the patient attempts to swallow, there is constant danger of insufflation pneumonia. It is therefore advisable to administer food and laxatives by stomach tube and to give water by hypodermoclysis or by rectum. The Murphy drip has been found to be very satisfactory.

Stimulation should be given as required; strychnin probably being of value. Digitalin has been used extensively to combat cardiac failure, and pilocarpin may be used to relieve the dryness of the mouth and pharynx, although pilocarpin should be given with caution since the patient is unable to cough up fluid from the lungs if pulmonary edema is induced.

Specific antitoxin may be obtained and should be tried in every case although as yet its therapeutic value is not established. In laboratory experiments complete protection may be given if the antitoxin and toxin are administered simultaneously or nearly so, but the amount of clinical data available is still too small to enable us to draw any conclusions as to the actual therapeutic value in human cases. It has been demonstrated experimentally that prophylactic injections of antitoxin are of value for laboratory animals and it is undoubtedly true that the same is the case in human beings. There is therefore positive indication for prophylactic administration of antitoxin to all persons who are known to have eaten food which has caused this type of illness in other persons or in domestic animals or fowl.

It should be remembered that the known strains of *B. botulism* fall into two groups which are distinct in so far as their toxin-antitoxin relationship are concerned; in other words there are two types of *B. botulinus*, A and B, the toxin of each of which produces an antitoxin which will protect against the toxin of all analogous strains but which has no protective action against the toxin of the heterologous strains. For this reason it is essential that if a single antitoxin is administered, it should be a polyvalent serum, although a mixture of type A and type B antitoxin should be of equal value. A polyvalent serum is not as yet available but there is a moderate amount of available type A and type B serums which have been prepared for experimental purposes.

The pathology of botulism is interesting in that there is a characteristic cellular thrombosis in the blood vessels of various portions of the body. There is also marked general hyperemia, and frequently numerous hemorrhages are seen, particularly in the brains and lungs. Broncho-pneumonia is frequently found, being the result of the strang-

ling spells and the pharyngeal and laryngeal paralysis. The exact method in which the toxin acts upon the tissues is, however, unknown.

As stated in a previous paragraph, the problem of botulism is essentially one which is of interest to California. The greatest number of cases have occurred in this state, and both home-canned foods and commercially canned foods which were packed in California have been shown to be the cause of the poisoning. It must be emphasized that the relative number of outbreaks of poisoning is extremely small, and the vast majority of containers of canned food, whether home-canned or commercially canned, are free from any danger. The fact that poisoning may occur, however, must be recognized, and housewives should be instructed of the possible danger. They should be told that it is unsafe to eat or even taste any preserved food which shows the slightest sign of spoilage, and that all spoiled food should be discarded in such a way that neither human beings nor domestic animals or fowl may have access to it. They should also know that the toxin of *B. botulinus* is easily destroyed by heating and that if preserved food is boiled after it is removed from the container and before it is eaten or even tasted, all danger of food poisoning of this type will be removed.

It is not necessary or advisable that the consumption of preserved foods should be curtailed, or that the home-canning of perishable foods should be discontinued. It is necessary, however, that the problem of botulism be looked upon as one of importance to the public health, and it should be the duty of every physician in the state to aid in preventing outbreaks by instructing his patients concerning the possible danger of poisoning and the way in which it can be prevented.

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THE RADIOGRAPHIC STUDY OF THE ABDOMINAL ORGANS AFTER INFILTRATION OF THE PERITONEAL CAVITY.*

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As is well known, any part of the body may be made visible under the Roentgen rays if we can only make its degree of resistance to the passage of those rays different from that of the surrounding tissues. We may make it more resistant by injecting suspensions of barium or we may make it less resistant by injecting air. Many have used air or oxygen in radiographing the bladder, colon (1), stomach (2), and knee-joints (3). Recently oxygen has been used to

outline the cerebral sinuses. For a number of years the German radiologists have been experimenting with the injection of air or oxygen into the peritoneal cavity. Lorey (4) in 1912 seems to have been the first to show radiographs taken after injecting air into the abdomen of a patient who had been tapped for ascites. A great deal of credit should be given to Weber (5) who began in 1912 to work out this technic on animals and cadavers. His published plates are excellent and it is surprising that his epoch-making article in a widely read journal should have been so completely ignored and forgotten by the profession. Although a few papers (6) appeared on the subject in the next few years, it was not until 1918 (7) that the men in Europe seemed to wake up to the possibilities of this method of diagnosis. While in the East last June I saw some beautiful plates taken with this method by Drs. Stein and Stewart of New York (8). These impressed me so much that immediately upon my return to San Francisco I began experimenting on animals to satisfy myself of the harmlessness of the procedure, and later to see if I could modify it so that it would be more convenient for use at the office. Its harmlessness in suitable cases seems to have been well established, as no accidents have been reported from the clinics in which it has been used extensively. Rabbits and guinea pigs can be distended with O_2 or CO_2 to a degree not approachable in man, without producing any signs of distress or concern. Strange to say the rapid absorption of these large quantities of gas does not bother their respiratory centers.

The more I work with this method on man the more enthusiastic I become, and the more convinced that we have here the biggest advance in radiologic technic since the introduction of the bismuth meal by Cannon in 1898.

Technic.

The patient ordinarily should have the bowel and stomach empty. In certain cases, however, good results are obtained by having the bowel filled with barium. I believe it advisable to give the patients a quarter of a grain of morphin hypodermically fifteen minutes before the injection because otherwise some will be very restless and will complain of pain. Nervous women will be quieted by the sedative and will be less likely to get panicky if they feel faint and oppressed about the heart. Some of the more phlegmatic individuals do not seem to feel much distress and complain only about the abdominal distension.

I use a spinal puncture needle which is thrust through the left rectus muscle near the navel. The skin is painted with a little iodine. No anæsthetic is needed. With a little practice one can tell

* From George Williams Hooper Foundation for Medical Research, University of California Medical School, San Francisco.

- (1) Henzelmann: Wien. klin. Wchnschr., 1918, 31, 915.
Löffler: Münch. med. Wchnschr., 1914, 61, 763.
- (2) Nieden: Deutsche med. Wchnschr., 1911, 37, 1515.
- (3) Hoffa: Berl. klin. Wchnschr., 1906, 43, 940.
Jacobsohn: Deutsche med. Wchnschr., 1907, 33, 703.
- (4) Lorey: Verhandl. d. dtsch. Roentgen Gesellsch., 1912, 8, 52.
- (5) Weber: Fortschritte a. d. Gebiete d. Roentgenstr., 1913, 20, 453.

- (6) Meyer-Betz: Münch. med. Wchnschr., 1914, 61, 810.
Rautenberg: Dtsch. med. Wchnschr., 1914, 40, 1205.
Berl. klin. Wchnschr., 1914, 51, 1608.
- (7) Goetze: Münch. med. Wchnschr., 1918, 65, 1275.
Schmidt: Deutsche med. Wchnschr., 1919, 45, 201.
Schlittenhelm: Deutsche med. Wchnschr., 1919, 45, 566.
Rautenberg: Berl. klin. Wchnschr., 1917, 54, 22.
Alessandrini: Policlínico, 1919, 26, 641.
- (8) Stein and Stewart: Ann. Surg., 1919, 70, 95.